

In the period under consideration, the following research work was carried out:

1. The study of resonance radiation in the neighborhood of the plasma frequency and in the absence of external magnetic fields was completed. The major results are as follows: (1) Major modifications of existing formalisms have to be introduced only if the gas ensemble as a whole is relativistic. Since this is not the case in astrophysical sources of immediate interest, it was decided not to pursue this aspect in detail. (2) The response to the passage of a relativistic particle or particle beam by a non-relativistic back ground gas is basically the same as the response to a non-relativistic particle. In particular, no new harmonic structures appear. (3) The differences in the response to relativistic and to non-relativistic test particles affect mainly the continuous radiation and are of comparatively little importance for the plasma resonance. A report covering this phase of the work is in preparation and will be submitted for publication by NASA.
2. Dr. Anand, formerly of our group and now at the California Institute of Technology, is continuing research on the influence of magnetic fields which leads to exceedingly complex expressions. It was decided not to make a major effort in this direction here, since it became apparent that no immediate application to the research area covered by the Grant would be forthcoming. Dr. Anand plans to write up the whole project for publication, including whatever magnetic field effects can be treated.
3. Work is continued on the fate of particle beams in the solar corona. In progress is a quantitative study of the interaction of particle beams with the coronal plasma that would make it possible to relate non-thermal radio emissions with a variety of high energy, in particular, X-ray features.
4. The basis for this work was completed earlier. In order to identify X-ray events unambiguously with particle beams it was necessary to exclude the possibility that at least the high energy tail of the X-ray spectrum emitted in connection with solar flares is due to the presence of very hot elements of thermal character. The arguments used were the cooling rates. It was already known that radiative cooling would be insufficient to remove thermal energies at temperatures in excess of the coronal value in times short enough to be identified with flares. The remaining uncertainty involved conductive cooling. It was possible to show that conduction in fact would equalize temperatures in the  $10^6$  K range in times much shorter than the observed flare times. Since it is highly unlikely that these conduction losses would be inhibited in all flares by magnetic fields of a very special geometry, it appears reasonable to consider the X-ray events as solely due to the more or less isolated, non-thermal particle beams.
5. At this point it appeared to be desirable to learn more of the conditions under which particle acceleration may occur in the course of a solar flare. One approach which has recently been found successful is the study of thermal instabilities. The application of this concept to the flare problem showed

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that the chromospheric plasma indeed may become unstable and may produce an event which, though drastically idealized, can be identified with a flare and its manifestations in the optical spectrum. However, it was necessary to introduce a heating mechanism which in reality would correspond to either and influx of energetic particles, or of shock energy from layers below. In either case it appears unlikely that the phenomena which produce the optical emission are themselves involved in the production of high energy particles. A report on this work is in preparation.

6. Since the deduction of the basic stability criteria and the evaluation of heating and cooling functions had to be done for a wide range of physical parameters (density, temperature, etc.), we felt that the already available techniques should be used in as wide a range of phenomena as possible. In particular, the application to the formation of prominences is obvious. Work on this and related problems is in progress. An abstract that discussed the stability of interstellar gas was presented by J. Hunter at the summer meeting of the AAS.

7. Work on the influence of activity centers on the solar wind continued and is near completion. It was found that the geomagnetic activity which in turn is related to the solar wind velocity is strongly correlated to the central meridian passage of plage areas with or without sunspots. There is clear statistical evidence that shows that the actual geometry of the magnetic field structures as observed in the photosphere is of little or no importance for the amplitude of the geomagnetic effects, and that the probable cause is the enhanced magnetic field in the whole area marked by the plage area, rather than the localized fields in sunspots proper. A report on this work is in preparation.

8. Out of discussions concerning this subject grew an investigation of the periodicity of solar activity as evidenced by various indices. It was found that in recent years a clear trend could be observed that appeared to cause a periodicity that is not related to the solar rotation. These results were discussed by Altschuler and Sastry in a paper in NATURE.

Publications originating under the Grant in the report period:

- (1) The Emission of the Quiet Corona at Meter Wavelengths, by L. Oster and S. Soria, *Astroph. J.* 141, 1139
- (2) Autocorrelation of Solar Activity, by M.D. Altschuler and Ch.V. Sastry, *Nature* 206, 1035
- (3) The Stability of the Interstellar Gas, *Astronomical J.*, in press, by J. Hunter.

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